



## PEDESTRIAN INJURY AND SOCIAL EQUITY IN OREGON

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SUBJECT: Analysis of Pedestrian Injury, Built Environment, Travel Activity,  
and Social Equity

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### INTRODUCTION

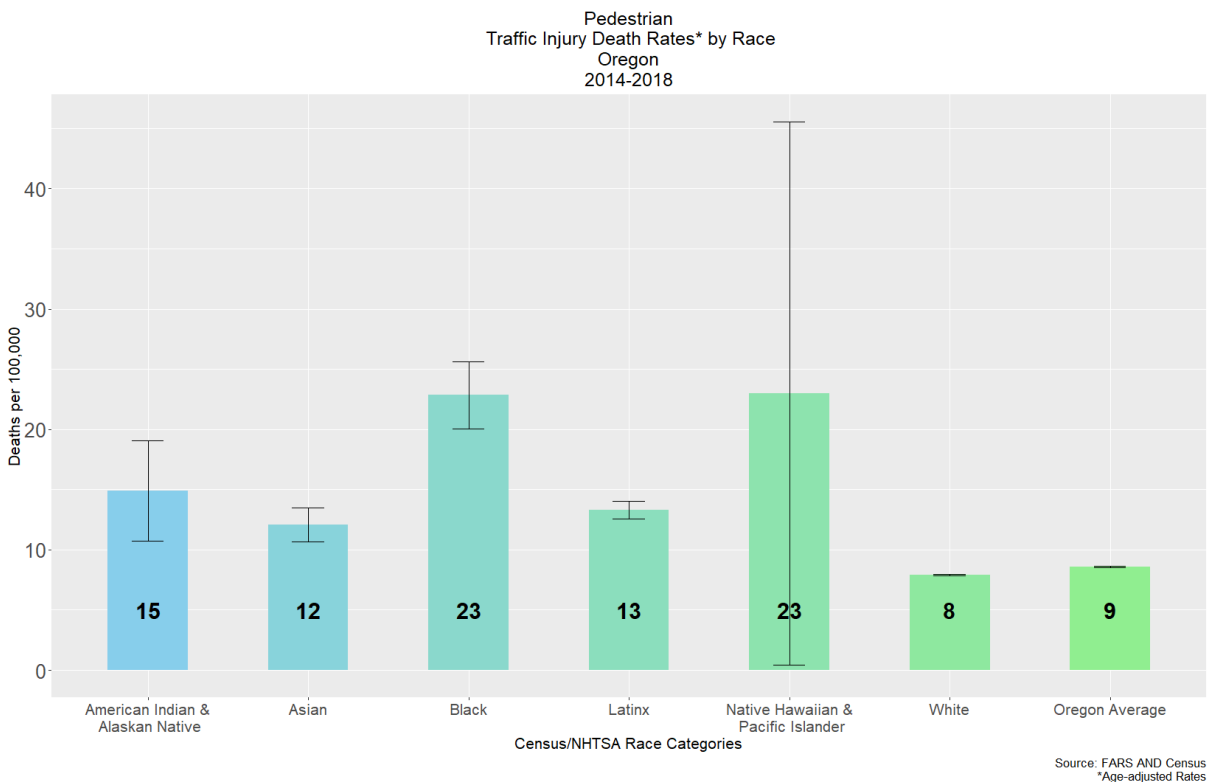
In October of 2020 the Oregon Transportation Commission formally adopted its Strategic Action Plan (SAP) which identifies equity as one of three priorities. The SAP calls out the disparate pedestrian crash rates in low income areas and communities of color and the need to prioritize improvements for people that rely on walking, transit, and biking across the state. Past research and planning has highlighted the existence of pedestrian injury disparities throughout the US and some local agencies have performed cursory analysis in Oregon. However, no statewide analysis of pedestrian injuries has been completed to see how these injury outcomes differ by race and income. This technical memo aims to fill that gap by highlighting key findings of active research currently being performed by ODOT to better understand the factors that result in disparate pedestrian injury outcomes for different sociodemographic groups. It's important to recognize these disparities and understand the underlying conditions that create them so that targeted and effective action can be taken. The information presented below aims to inform that process.

This report shows that fatal pedestrian injury rates are higher for people of color using direct measures of fatally injured pedestrians. To better understand some of the reasons behind these disparate rates, and to understand why areas with more low income Oregonians experience higher rates of pedestrian injury, an analysis of pedestrian fatal and severe injuries is summarized using Census tract measures. This analysis shows that tracts with more low income people and a higher proportion of people of color have a higher rate of pedestrian injury. Contributing factors include higher vehicle volumes and more people in those communities using public transit or walking to access their work place. We are not able to directly measure the availability of pedestrian safety features, such as sidewalks and crossing improvements, because there is no comprehensive database to track the location of these improvements statewide, but research from other cities has documented the deficiency of these facilities as a contributing factor.

States can measure pedestrian traffic fatalities by race using data from the Fatal Accident Reporting System (FARS). These data are combined with data from the US Census to calculate

age-adjusted rates for each race and ethnicity. These results are presented in Figure 1 below and provide the most direct measure of disparity in pedestrian injury outcomes by race. These results show that BIPOC<sup>1</sup> populations experience a higher burden of fatal pedestrian injury. Black and Native Hawaiian and Pacific Islander populations experience the greatest disparity followed by American Indian and Alaskan Native people then Latinx people and finally people the Census defines as Asian. It should be noted that the calculated rate for Native Hawaiian and Pacific Islanders is based on two fatal injuries and a relatively small population statewide making this rate rather imprecise. However the measured disparity for other BIPOC populations is significantly different than the state average.

**FIGURE 1: FATAL PEDESTRIAN INJURY RATES BY RACE**



Key contributors for these disparities are summarized in the next section of this memo which describes two pathways including travel behavior and the built environment. People who are low

<sup>1</sup> This memo will use the term Black, Indigenous and People of Color (BIPOC) to describe people that the US census designates as American Indian and Alaskan Native, Asian, Black, Latino, Hispanic, Native Hawaiian and Pacific Islander. Racial categories from the US Census will be aggregated based on statistical analysis conditions because the number of people in marginalized groups can sometimes be small, especially at the Census tract level and when dealing with samples. Maintaining disaggregation can often result in analytic results with little or no confidence due to sample size. An example of this statistical uncertainty can be observed in Figure 1 where the age-adjusted fatal injury rate for Native Hawaiian and Pacific Islander is rather imprecise, as noted by the confidence intervals, making a conclusion about this measure hard to interpret.

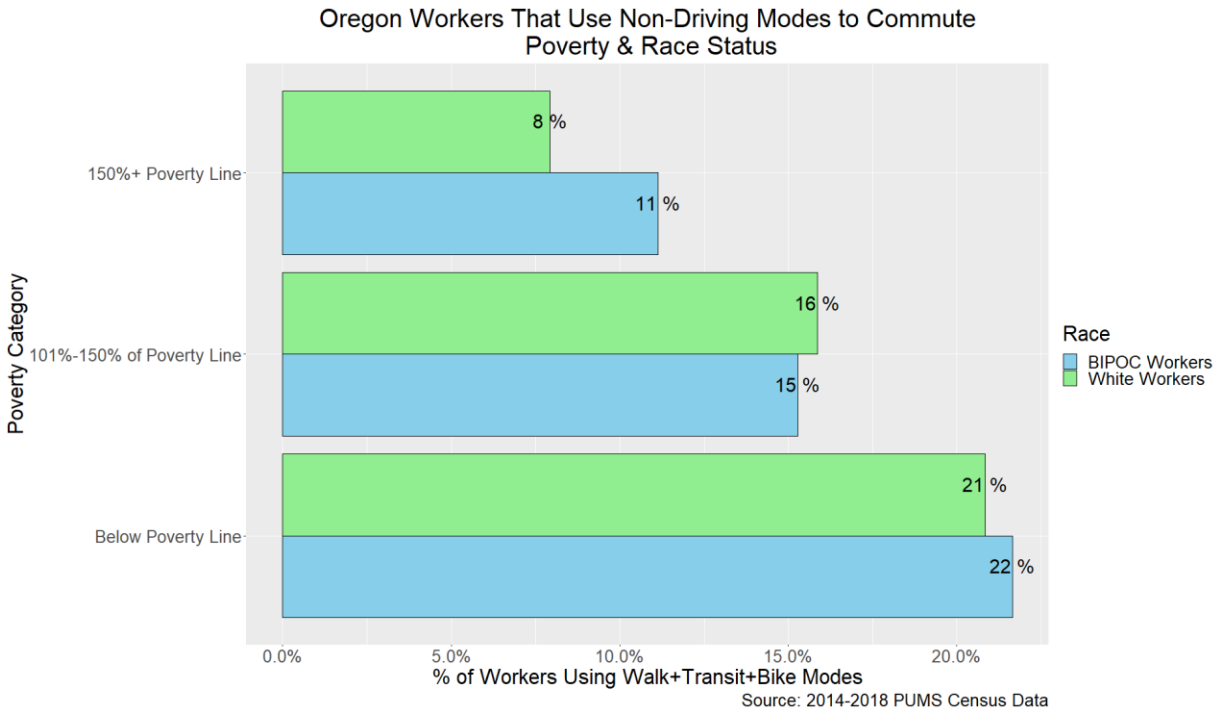
income and/or BIPOC are more likely to walk and take transit, meaning they have greater exposure as pedestrians to traffic safety risks. Further they are more likely to walk in environments with higher vehicle traffic volumes, less street connectivity, and fewer pedestrian safety features like sidewalks and crossings. These factors combine to result in higher pedestrian fatal injury rates for these groups. Because income of the crash participant is not a data element in federal or state crash data, a separate set of analyses are constructed using neighborhood level characteristics in order to quantify the role that poverty plays in pedestrian fatal and severe injuries. It should be noted that this ecological analysis approach limits the nature of conclusions wherein results can tell us about features that correlate to pedestrian injuries occurring within a tract, but does not always translate specifically to the people living in those tracts.

## TRANSPORTATION SYSTEM AND SOCIAL EQUITY PATHWAYS

The transportation system plays an important role in connecting people to economic and social opportunities but this access is not equitably distributed. This inequity can be observed in people's travel behavior and the built environment in which that travel occurs. While travel behavior is complicated, evidence demonstrates that household income is a strong predictor of vehicle ownership and neighborhood amenities like a walkable environment, both of which influence travel behavior. Further, land use and zoning policies, home lending practices, and housing affordability have all contributed to income and racial differences in housing locations. Indeed, over the past 40 years, income-based housing segregation has increased dramatically (Bischoff and Reardon, 2013). Housing policies and practices effectively cut off housing equity as a viable pathway to personal wealth creation for many Black families, resulting in a current 10 to 1 wealth gap between White and Black households (McIntosh et al, 2020). More germanely, such spatial separation has negative impacts on low-income and BIPOC communities, ranging from increased exposure to environmental hazards, inferior schools, exposure to crime, and diminished access to jobs (Galster and Sharkey, 2017). While the details of these factors influencing housing options for low-income and BIPOC people are largely outside the purview of the current technical analysis, the resulting segregated housing landscape contributes to different transportation experiences, travel options, and safety conditions.

### TRAVEL BEHAVIOR

The role that income plays in mode choice for work trips can be observed in Figure 2 below which summarizes commute mode share for Oregon workers using US Census data from 2014-2018. Compared to workers at or above the poverty line, workers living in poverty are more likely to get to work by a mode other than driving a motor vehicle. There is a very small difference between BIPOC workers and white workers in each poverty category and income seems to be the more significant factor predicting commute to work travel mode compared to race. There are nearly 200,000 workers, 10% of all Oregon workers that rely on transit, walking, or bicycling to get to work.



**FIGURE 2: WORKER COMMUTE MODE SHARE BY POVERTY STATUS**

Many transportation system users rely on non-driving travel because the cost to drive is prohibitively expensive. Nationally, the American Automobile Association estimates the annual cost to own and operate a vehicle is \$9,200 which can be out of reach for people living near or under the poverty line. The Table 1 below summarizes information about the burden of transportation costs travel by income and race based on questions from the most recent National Household Travel Survey (NHTS). This table shows that, compared to higher income and non-BIPOC households, people from low-income households and BIPOC households are more likely to report that travel is a financial burden. Low-income survey respondents are nearly twice as likely to walk or take transit due to the financial burden of travel compared to those making \$50,000 or more and BIPOC respondents are significantly more likely to walk in order to reduce the financial hardship of travel costs. Taking transit usually involves a walk trip so transit is an important generator of pedestrian activity. This walk activity will increase exposure to vehicle traffic and increase crash injuries if the street is not designed for multimodal use.

**TABLE 1 – FINANCIAL BURDEN OF TRAVEL – NATIONAL HOUSEHOLD TRAVEL SURVEY**

	Travel is a Financial Burden	Walk to Reduce Financial Burden of Travel	Take Public Transportation to Reduce Financial Burden of Travel
<b>Household Income</b>			
Less than \$25,000	55%	29%	21%
\$25,000 to \$49,999	43%	17%	10%
\$50,000 to \$99,999	35%	14%	9%
\$100,000+	25%	11%	11%
<b>Race of household respondent</b>			

White	36%	15%	10%
Black or African American	50%	24%	23%
Asian	47%	26%	30%
American Indian or Alaska Native	56%	30%	19%
Native Hawaiian or other Pacific Islander	49%	25%	20%
<b>Hispanic status of household respondent</b>			
Hispanic	50%	24%	19%
Not Hispanic	37%	16%	11%
Total	38%	16%	12%

The information presented above aims to establish that low income households and BIPOC populations tend to travel by non-vehicle travel modes more often than people with higher incomes or households of non-BIPOC people. Traveling more by non-motorized modes exposes those users of the system to more pedestrian injury risk.

## BUILT ENVIRONMENT

It's also important to recognize that the environment in which non-motorized travel occurs can often times be deficient of infrastructure that make walking safe. A lack of sidewalk completeness, safe pedestrian crossings, and street lighting, in addition to higher motor vehicle traffic volumes and speeds are all factors that increase pedestrian injury risk. Research from other states has demonstrated some pedestrian facilities like sidewalks and crossings are more likely to be missing or incomplete in neighborhoods with higher concentrations of low-income households and BIPOC populations. Though studies have not yet been performed in Oregon, studies from other US cities lend insight to the magnitude of the pedestrian infrastructure deficiency in some communities. An analysis of over 3,000 counties across the country found that areas with higher levels of poverty and lower rates of educational attainment were less likely to implement sidewalk projects with federal funding (Craddock et al, 2009). A national study found that 89% of the streets in high-income areas had completed sidewalks while only 49% of streets had complete sidewalks in lower-income neighborhoods (Gibbs et al. 2012). Gibbs et al. (2012) also reported that 13% of streets in high income areas have marked crosswalks whereas only 7% of streets had this feature in low income areas, and that 75% of streets in high-income areas have street or sidewalk lighting compared to 54% in low income neighborhoods. National Household Travel Survey (2017) data reveals that low-income households were more likely to report that unsafe street crossings, heavy traffic, and lack of street lighting were barriers to walking.

Lack of safe pedestrian features in low-income areas represents one challenge with walking safely and accessing transit without incident. A compounding barrier includes the vehicle volume and speed on roads in many low income and communities of color. Nationally, lower income and BIPOC populations were more likely to live near high-volume roads of over 25,000 ADT (Rowangould, 2013). Significant evidence exists highlighting the increase in pedestrian risk with higher vehicle volumes and speed. The Oregon Department of Transportation first recognized the role vehicle speed and volume play in heightening pedestrian risk with the agency's first Pedestrian Safety

Implementation Plan (2014). Additionally, research synthesis by the National Academies of Science highlight the additional risk posed by roads and intersections with high volume, high speed motorized traffic (NAS 2018).

For low income communities and communities of color the convergence of travel activity and the built environment present a disproportionate risk to pedestrians in those neighborhoods that results in similarly disproportionate pedestrian injury rates. In a literature review of factors influencing pedestrian crash, injury and fatality risk, numerous studies found that sociodemographic factors are connected to pedestrian safety outcomes (see table 2). Neighborhoods with higher proportions of BIPOC residents are associated with more pedestrian injuries. Lower-income areas have higher pedestrian crash rates, higher poverty rates are associated with higher pedestrian injury rates, and areas with a higher proportion of people with limited English proficiency are associated with higher pedestrian crash rates. Taken together the published peer reviewed research suggests a systemic set of issues for pedestrians in low income neighborhoods and communities of color. The next section analyzes Oregon crash and population data in order to highlight existing conditions within the state that mostly reflect the findings in past studies.

**TABLE 2 - LITERATURE REVIEW: SELECT PEDESTRIAN CRASH SOCIODEMOGRAPHIC FINDINGS**

Variable	Summary of significant findings
Race / Ethnicity	<ul style="list-style-type: none"> <li>Seven studies found that higher proportions of BIPOC residents are associated with more pedestrian crashes (Abdel-Aty et al 2013; Apardian and Smirnov 2020; Chimba et al 2014; Guerra et al 2019; Lin et al 2019; Loukaitou-Sideris et al 2007; Mansfield et al 2018), including: <ul style="list-style-type: none"> <li>five finding specific connections between higher African-American or Black populations and pedestrian crashes (Apardian and Smirnov 2020; Chimba et al 2014; Guerra et al 2019; Lin et al 2019; Mansfield et al 2018);</li> <li>two finding connections between higher Latino/a populations and pedestrian crashes (Chimba et al 2014; Loukaitou-Sideris et al 2007), and</li> <li>one finding a connection between higher Asian populations and fatal pedestrian crashes (Mansfield et al 2018).</li> </ul> </li> <li>Conversely, two studies found higher white populations to be associated fewer pedestrian crashes (Chimba et al 2014; Yu 2014)</li> </ul>
Income and Poverty	<ul style="list-style-type: none"> <li>Six studies found higher household income to be associated with fewer pedestrian crashes (Cottrill and Thakuriah 2010; Dai and Jaworski 2016 DiMaggio 2015; Jermprapai and Srinivasan 2014; Mansfield et al 2018). <ul style="list-style-type: none"> <li>One study found household income to be associated with more pedestrian crashes (Chimba et al 2014).</li> </ul> </li> <li>Five studies found that higher proportions of households in poverty to be associated with more pedestrian crashes (Chakravarthy et al 2010; Chimba et al 2014; Guerra et al 2019; Jermprapai and Srinivasan 2014; Wier et al 2009).</li> </ul>
Non-English Language	<ul style="list-style-type: none"> <li>Three studies found connections between higher proportion of non-English speaking residents and more pedestrian crashes (Chakravarthy et al 2010; Dai and Jaworski 2016; Jermprapai and Srinivasan 2014).</li> </ul>

## SOCIAL EQUITY AND PEDESTRIAN SAFETY ANALYSIS

This section uses a standardized scoring technique to first determine whether Oregon tracts with greater concentrations of low income and BIPOC populations' exhibit higher population-based pedestrian injury rates. The results of the analysis demonstrate that the pedestrian injury outcomes in Oregon are not equally distributed across all communities: Pedestrian injuries are higher where low income people and BIPOC communities reside. This analysis approach cannot definitively say that the injuries are being experienced by people residing in those Census tracts where the injury occurs. However, research from other cities has documented the typical distance from home that pedestrian injuries occur with Haas et al. (2015) finding that half of pedestrian injuries occur within 1.1 miles from the victims home and Anderson et al. (2012) finding that half of pedestrian injuries occur within 1 mile from home. Anderson et al. found that for children and the elderly, the injury distance from home was even shorter with half the injuries occurring within a half-mile of the victim's home. Future research in Oregon should try and determine the typical distance from home that pedestrian are when injured by a motor vehicle to offer more conclusive direction regarding the relationship of Census tract characteristics and pedestrian injury outcomes.

### DATA

Data for the analysis below comes from a number of sources, including ODOT's Crash Data System, US Census's American Community Survey (ACS), Highway Monitoring Performance System (HPMS) and General Transit Feed Service (GTFS). ODOT maintains the crash data of record for the state and measures the severity of pedestrian injury based on police reports. Socio-demographic data on injured participants is not recorded by ODOT but population data at the tract level is collected annually based on a one percent sample of the population through the ACS. Commute mode is collected for workers as a part of the ACS survey and can reveal if the worker uses transit, walks or uses some other mode of travel to work. The HPMS is the data of record for vehicle volumes reported to the Federal Highways Administration (FHWA) and is generated by collecting traffic counts throughout the system. HPMS also collects the posted speed on roadways where volumes are reported. GTFS data are collected from each of the transit agencies operating in Oregon and include measures of transit supply and the stops that the transit vehicles service.

Together, these data provide a meaningful picture into general travel behavior, motorized traffic conditions and related pedestrian traffic safety outcomes; however this analysis is not without limitations. An important data element missing from this analysis are measures of pedestrian safety infrastructure such as the number and quality of sidewalks and crossing features. These data are available for some parts of the transportation network but not available across the state in a uniform manner. Without pedestrian infrastructure data for statewide analysis, we hypothesize that socio-demographic data functions as a proxy for the presence of these safety features. This hypothesis is informed by past research documenting the pedestrian system gaps in low income areas and communities of color in other states. More work should be done to measure this deficiency in Oregon.

## STANDARDIZED SCORING ANALYSIS

In this section, an analysis procedure is performed that categorizes Oregon Census tracts based on poverty and race values. The factors include percent of population living in poverty and percent of the population that are BIPOC. The measures are standardized for each tract by calculating a z-score statistic for each data element. Standardized scores, or z-scores, are a measure of standard deviations from the statewide average for a given tract value and gives a clear sense of whether that tract exhibits a higher or lower measure compared to the state average. These values are calculated using the following equation:

$$Z_{id} = \frac{x_d - \mu_d}{\sigma_d}$$

Where:

$Z$  is the standardized score for tract  $I$  for measure  $d$

$x$  is the measure for tract  $I$  for element  $d$

$\mu$  is the average statewide value of measure  $d$

$\sigma$  is the standard deviation of the measure  $d$

In addition to being able to see how each individual factor compares relative to the statewide average, standardized scores can be added together into a composite score. This composite score can then be used to determine tracts that have lower or higher concentrations of each of the factors. Combining the measures of poverty rate and BIPOC population in this way simply shows which tracts measure higher or lower than the state average on these two measures. Tracts with composite values within one standard deviation below the state average are considered to have low concentration of these populations while values greater than one standard deviation are considered to have the lowest concentration of poverty and people of color. Tracts with composite values within one standard deviation greater than the state average are considered to have moderate concentration of these populations while values greater than one standard deviation are considered to have high concentration of poverty and people of color. Table 3 below summarizes poverty and BIPOC population based on these concentration categories (Lowest, Low, Moderate and High). The table also summarizes pedestrian injury outcomes, travel activity information, built environment and the total population. Tract designations can be reviewed for select urban areas in the Appendices A1 through A3 to better understand what these look like when applied spatially.

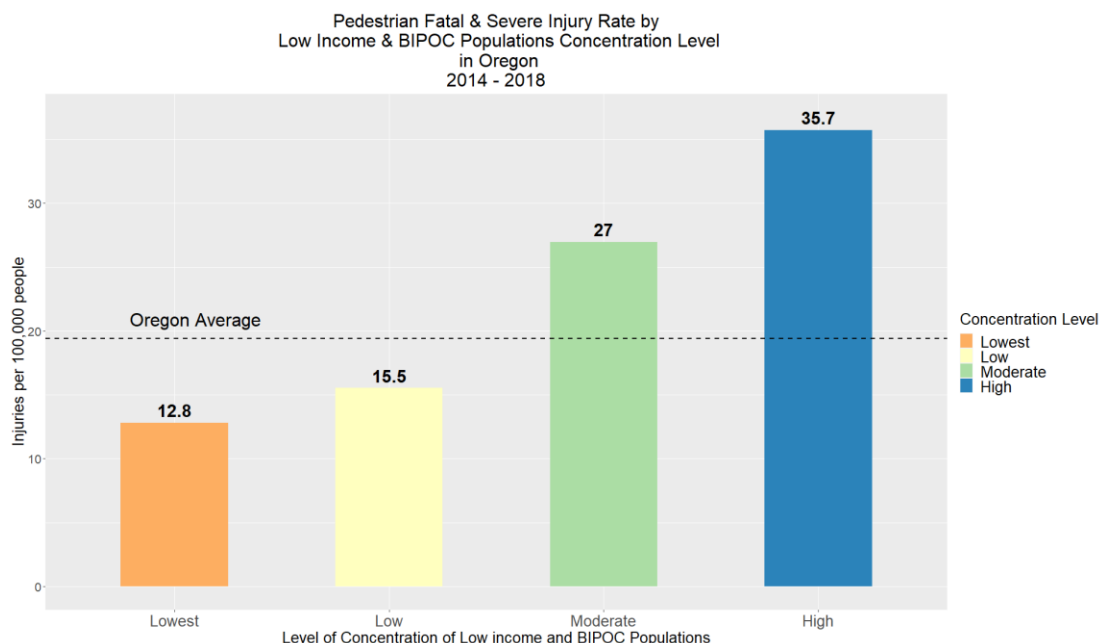
The average poverty rate is 23% in tracts classified as high in the concentration index compared to the statewide average of 14%. The average proportion of the population in high concentration tracts that are BIPOC is 33% compared to the statewide average of 20%. As designed, the standardized scoring method puts tracts with values higher than the state average in the upper categories and those with lower values, compared to the state average, in the lower categories.

The summary information in Table 3 shows that 1.002 million Oregonians, or about 24% of the total population, live in a Census tract designated as having a high concentration of low income and BIPOC populations but have 894 fatal and severe pedestrian injuries, or about 40% of the total injuries. Calculated as an injury rate by dividing the number of injuries in the tract by the

population, it is observable that disparities exist between the concentration categories. The pedestrian fatal and severe injury rate in tracts classified as high in the concentration index is over two times the rate in the lowest category and 63% higher than the statewide average. The fatal and severe injury rates are summarized in Figure 3 below showing that the injury rate for tracts categorized as high concentration having over three times the rate (203.8 vs. 54.4) as the lowest category and 81% higher than the state average.

**TABLE 3 – STANDARIZED SCORING DATA SUMMARY**

Data Category	Measure	Concentration Index				Statewide
		Lowest	Low	Moderate	High	
Socio-Demographic & Population	% People Living in Poverty	8%	12%	15%	23%	14%
	% People of Color	10%	16%	22%	33%	20%
	Population	1,139,724	1,165,118	774,907	1,002,194	4,081,943
Pedestrian Injury	Fatal & Severe Injury Rate	12.8	15.5	27.0	35.7	21.9
	All Injury Rate	54.4	78.9	129.3	203.8	112.3
	All Injury	146	181	209	358	894
	Fatal & Severe Injury	620	919	1002	2042	4583
	Average Fatal & Severe Injury	0.6	0.8	1.4	1.8	1.1
	Average Pedestrian Injury	2.6	3.8	6.5	10.5	5.5
Travel & Built Environment	Arterial VMT Density (Millions VMT per Sq Mi)	493,726	634,285	1,052,054	1,459,501	865,363
	Miles of 45 MPH Roadway per 100 Sq Mi	0.52	0.48	0.90	1.05	0.70
	Transit Stops per Sq Mi	12	18	28	42	24
	% Household without Vehicle	3.7%	5.9%	8.2%	12.3%	7.2%
	Walk and Transit Commute %	5.8%	9.0%	12.3%	16.3%	10.5%

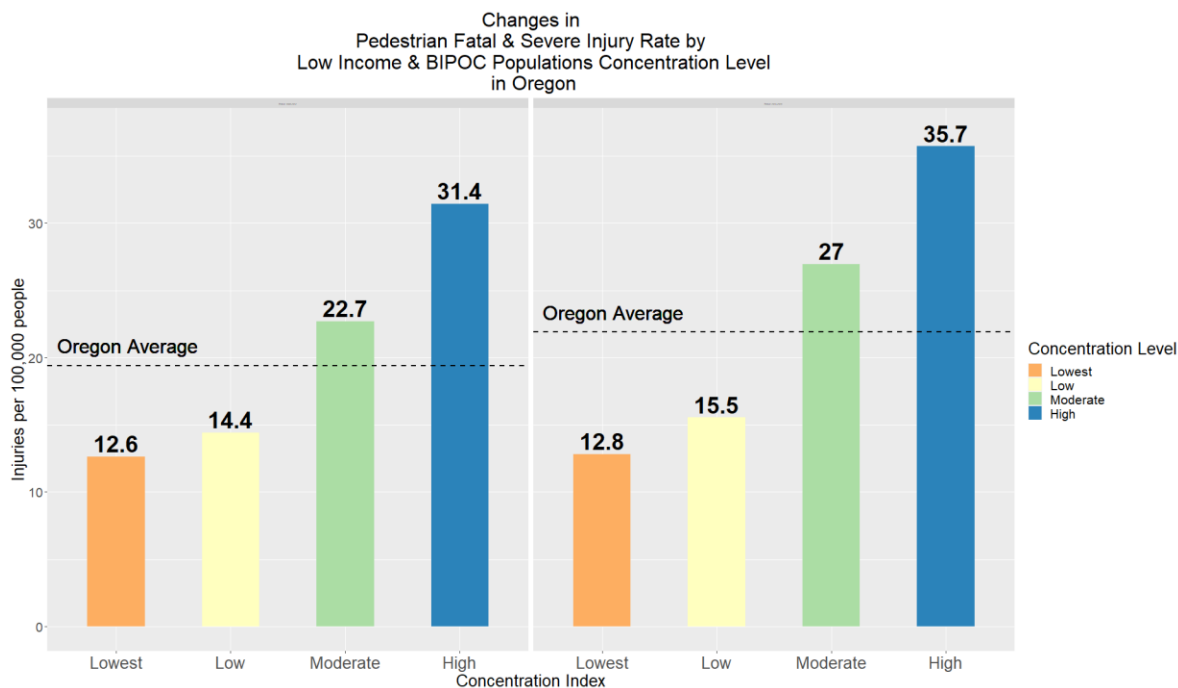


**FIGURE 3 – PEDESTRIAN FATAL AND SEVERE INJURY RATE BY CONCENTRATION LEVEL**

The index also reveals that the transportation environment is harsher for pedestrians in tracts with higher levels of poverty and higher proportion of BIPOC residents. The average arterial vehicle miles travel (VMT) density in tracts classified as high is nearly three times higher than the lowest category and about 68% higher than the state average. Arterial VMT density is calculated by aggregating all the arterial VMT in the tract or on the border of a tract and dividing by the tract area. In addition to arterial VMT, a measure of roadway speed is also summarized. Miles of roadway signed as 45 miles per hour or higher per square mile summarizes the high speed roadway miles in a tract normalized for the area of the tract. In tracts categorized as high in the concentration index, there are nearly twice as many high speed roadway miles per square mile compared to the lowest index category.

Compounding this exposure to more vehicle travel and higher speeds, workers in tracts classified as high concentration also walk, take transit, and bicycle to work more than workers in tracts in the lowest category and the state average. The number of transit stops per square mile are also summarized and show that in high concentration tracts the number of transit stops is nearly four times higher than the lowest category. Lastly, the average percentage of households without a vehicle is summarized for each concentration category showing that for tracts in the high category over 12% of households are without a vehicle, four times the rate for the lowest category and higher than the statewide average. These measures of non-vehicle travel are proxies for increased pedestrian activity.

The analysis results presented in Table 3 and Figure 3 use data from 2014 through 2018. In order to understand if these measures have changed, the pedestrian injury rates were also calculated for years 2018 to 2012. Figure 4 below shows that the overall state average injury rate for all severities has increased over time (see "Oregon Average" dotted line), but has grown faster in



**FIGURE 4 – PEDESTRIAN FATAL AND SEVERE INJURY RATE BY CONCENTRATION INDEX OVER TIME**

tracts classified as having higher concentrations of people living in poverty and BIPOC communities. The other data features for the 2008 to 2012 period are shown in more detail in Appendix A which shows multiple data sets over time by concentration level index.

## SUMMARY

This technical memo aims to inform the 2020 Transportation Safety Action Plan process by showing how BIPOC populations experience a disproportionately high fatal pedestrian injury rate and that tracts with higher concentrations of lower income people and BIPOC populations are where high numbers of fatal and severe injuries occur. Using FARS data, age-based rates are calculated for each race and ethnicity showing that BIPOC populations experience a disproportionate fatal injury burden on the population with Black people experiencing the greatest disparity, followed by American Indian and Alaskan Native, then Latinx with Asian also having a higher rate of pedestrian injury than the state average.

An analysis of pedestrian injuries by Oregon Census tracts shows that the places where low income and BIPOC populations are more concentrated have measurably higher levels of vehicle traffic and higher speed arterials. People in these communities walk, take transit, and bicycle to work at higher rates than communities with fewer low income people and BIPOC populations. In addition to this work travel behavior, communities with a greater concentration of poverty and BIPOC populations have more transit stops and therefore are likely to use transit for non-work travel more than tracts with fewer transit stops. Combined, the higher walking activity in areas with more traffic moving at higher speed are likely drivers of the pedestrian fatal injury rate disparity between tracts.

These higher rates also coincide with places that have higher concentrations of low income and BIPOC populations though we cannot say for sure that it's the people in those communities involved in the recorded crashes. Tracts within each concentration category tend to cluster so it's likely that pedestrians are involved in a collision in a nearby tract with similar socio-demographic and built environment characteristics. Additionally, past research from other regions have shown that half of all pedestrian injuries occur within 1.1 miles of a person's home.

The findings presented in this technical memo support a growing body of evidence documented in the research literature that there are substantial relationships between race, income, and pedestrian injury outcomes. The likely pathways for the disproportionate pedestrian injury outcomes in tracts with higher proportion of BIPOC and low income are that people in these tracts walk more to meet their daily needs including taking transit and they perform that travel activity on streets with more vehicle traffic moving at higher speeds. What isn't known is how much of the pedestrian system is missing in any given tract because there is no comprehensive database of pedestrian infrastructure features such as sidewalks, crossings, traffic calming, and street lighting, among others safety features. Having these measures would inform where the gaps are in the system and give a clearer understanding of mechanisms for the disparate pedestrian injury rates. More direct measures of pedestrian activity would also be useful to understand these observed disparities and target interventions at locations with more pedestrian activity and a deficiency in

safe infrastructure. Vehicles are counted systematically and allow for good measures of vehicle volumes but no such comprehensive monitoring program exists for walk trips.

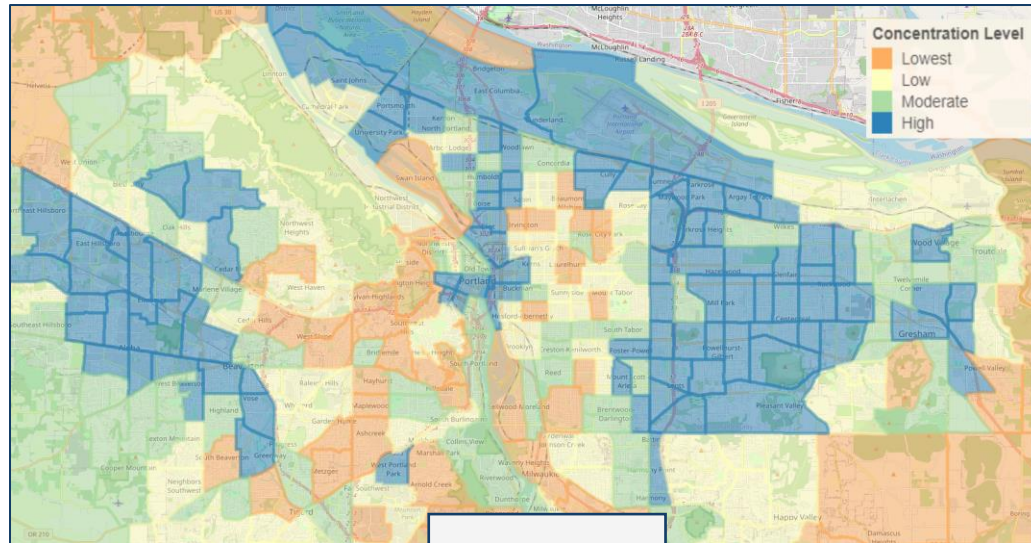
Additional research is underway by ODOT and some of these gaps and limitations will hopefully be addressed using more advanced analysis techniques to measure more precisely the role that each of the risk factors play on predicting the likelihood of pedestrian injuries at the tract and network level.

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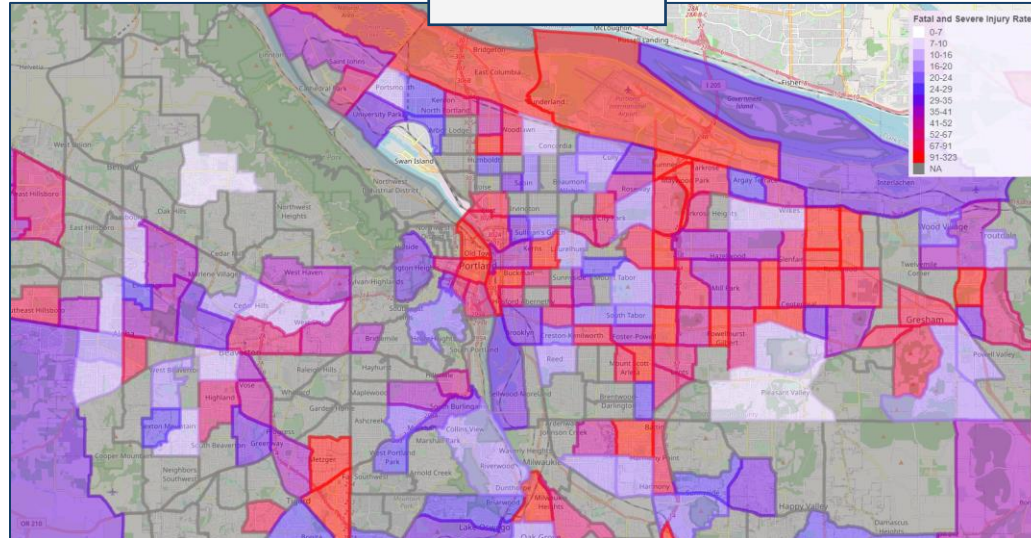
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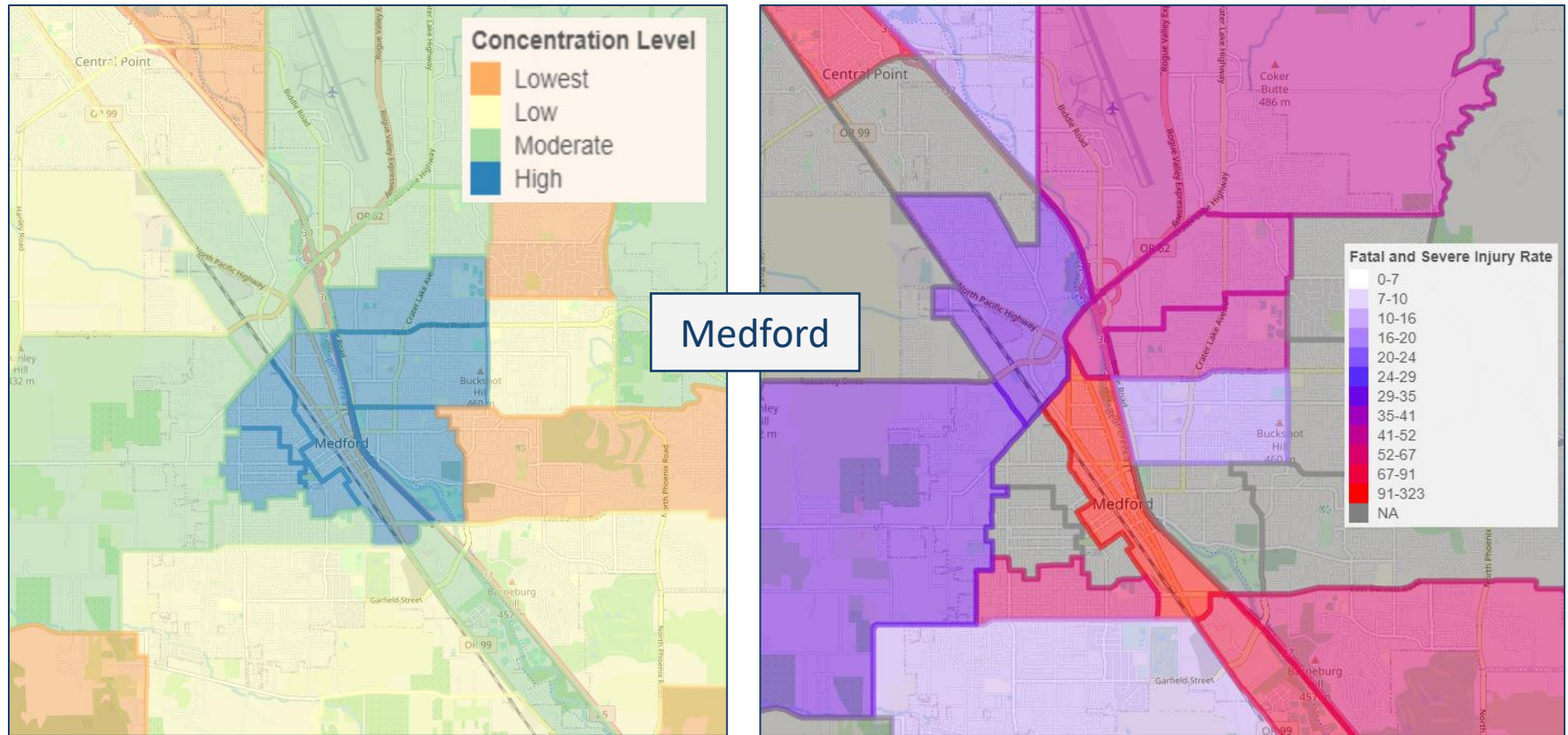
## APPENDIX A1



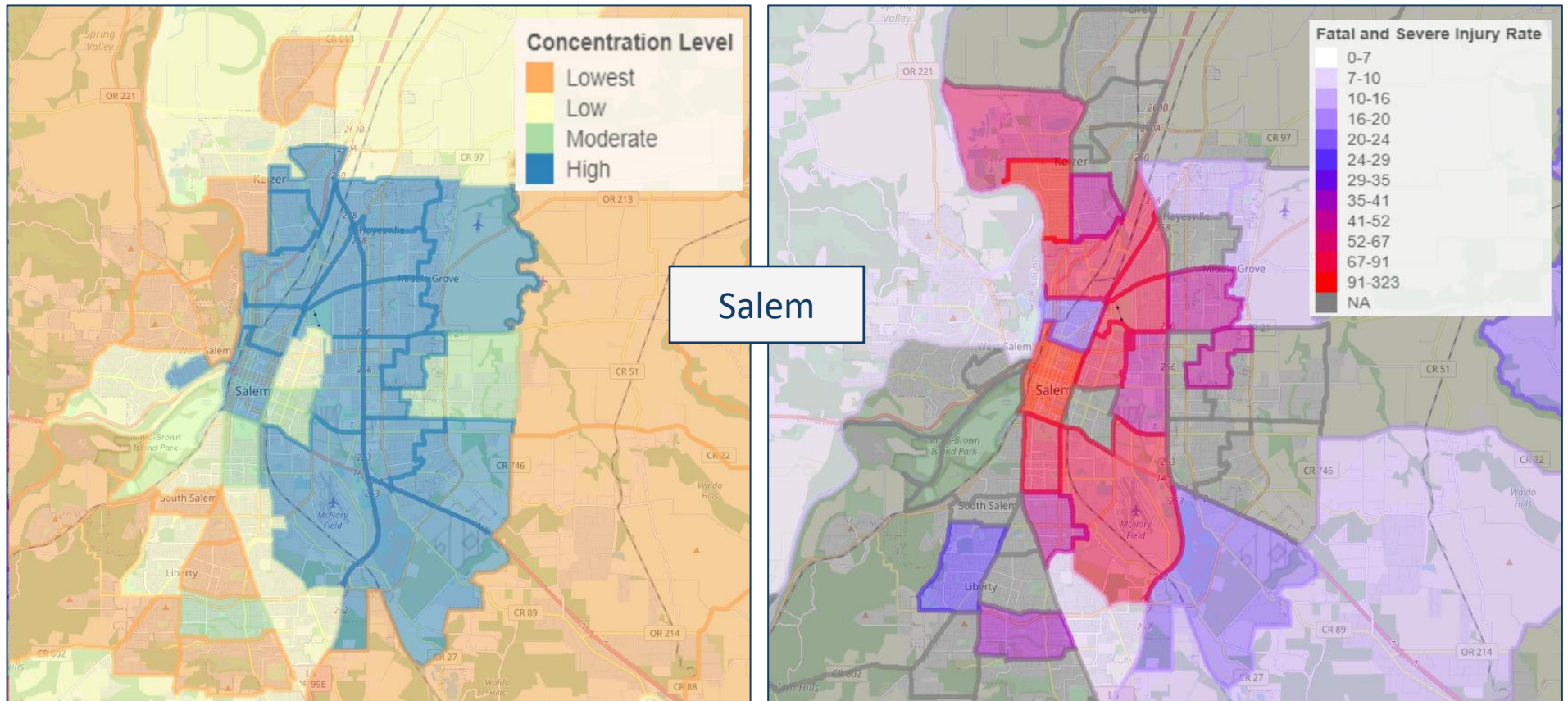
Portland



## APPENDIX A2



## APPENDIX A3



## APPENDIX B

Changes in  
Pedestrian Fatal & Severe Injury Rate by  
Concentration Level  
in Oregon

